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Taking the Moral High Ground?

The Reduction of Private Car Usage Through a Sense of Obligation

David Broadstock[1], Alan Collins[2], Adam Cox[3], Neil Ferguson[4], and Lee Woods[5]

Address for correspondence: Alan Collins, Department of Economics, Nottingham Trent University, 50 Shakespeare Street, Nottingham NG1 4FQ (alan.collins@ntu.ac.uk).

[1]Faculty of Business, the Hong Kong Polytechnic University, China.
[2]Department of Economics, Nottingham Trent University, UK.
[3]Economics and Finance, Portsmouth Business School, University of Portsmouth, UK.
[4]Department of Civil Engineering, Strathclyde University, Glasgow, UK.
[5]School of Civil Engineering and Surveying, University of Portsmouth, UK.

Abstract

This study investigates the extent to which a sense of moral pressure to reduce car usage is influenced by household decisions about vehicle use. There is a higher probability of feeling moral pressure among those driving more, those driving larger vehicles, and those using more fuel-efficient vehicles. This moral pressure is found to decrease for households with higher income and households further away from a city centre. Results suggest that there is room to shape transport policies to focus on those households that feel less moral pressure in reducing use of personal automotive vehicles.

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1.0 Introduction

A common element or higher order aim of many transport policies in mature Western societies is an expression of interest in reducing use of personal automotive vehicles. The stated motivations for these expressions are many and varied (Abrahamse *et al*., 2009). They have been inspired by a wish to reduce traffic congestion, reduce accidents, support the health benefits of 'active travel' by discouraging excessive time in less healthy sedentary vehicle travel, generate improvements in air quality, and help reduce greenhouse gas emissions.

A range of planning, fiscal, and market-based policy instruments have been deployed to serve the purpose of changing travel behaviour or the breaking of habits. They have been complemented by softer, social movement and/or marketing-led, voluntary measures that exhort drivers to use vehicles less frequently (Cairns *et al*., 2008; James *et al*., 2017). Of these latter types of measures, government agencies and various environmental lobbying groups have communicated public messages that raise a moral dimension in the context of private vehicle use. At its core, this moral dimension features a dichotomy between self-interest and the impacts of private vehicle use externalities on the wider community. Such a dichotomy presents a moral dilemma that has a strong base in affinities for particular philosophical imperatives and/or political ideologies. Such affinities in turn condition the degree of acceptance of moral pressure (Bloomfield, 2008). Depending on viewpoint, some people might see an inherent contradiction in acting 'morally' and self-interest. Alternatively, some might consider that morality serves as a device to temper self-interest in order to facilitate cooperation and pro-social behaviour (Haidt, 2007), which may or may not involve self-sacrifice (high self-cost) (Sachdeva *et al*., 2015).

Among the wealth of research investigating changes in travel behaviour, there is a focus on exploring which factors influence travel behaviour. Examples include key life-course changes, household sociodemographic, and spatial context (Scheiner and Holz-Rau, 2013), or providing more information or raising awareness of alternative transport modes to challenge habitual behaviour (Kenyon and Lyons, 2003). In this vein, policy and academic discourse have sought to change travel behaviour by encouraging 'responsible driving', support the avoidance of 'unnecessary trips' by private vehicles, and highlight the 'environmental consequences' of driving vehicles (also to better inform people of alternative modes of transport that are more environmentally friendly). In some countries, community activist groups have campaigns of vandalism against some private vehicles; see, for example, Schrep (2011). Private vehicles were perceived to be elitist and materialist or ostentatious (Steg, 2005; Sheller, 2009), fuel-hungry, and wasting of natural resources simply by virtue of their manufacture. In essence, drivers in many countries have been exhorted through implicit through to explicit public and community messages to reduce vehicle use.

Their antagonists have sought to build a sense of guilt for vehicle use and to engender in them a moral obligation to reduce vehicle use. Thus, there is merit in empirically investigating the extent to which a sense of moral pressure to reduce vehicle use is influenced by the owner's vehicle use decisions, as evidenced by vehicle miles travelled, numbers of vehicles owned, and the attributes of the vehicles owned.

We make use of a unique postal questionnaire survey that asks participants to what extent they feel morally obliged to reduce their car use. The results indicate some

statistically robust influences, suggesting that a transport policy reinforcing feelings of moral obligation to reduce vehicle use can be effective. Furthermore, results suggest such policies may be best focused towards certain households. Increasing moral obligation needs to be reinforced with better knowledge of alternative transport modes, especially public transport.

The paper is organised in the following manner. The next section briefly reviews the measures that have been taken to reduce vehicle use via moral support and pressure, and without resorting to penalties and incentives. The data used in this analysis are described in Section 3. The modelling approach is discussed in Section 4. Results are presented and discussed in Section 5, and concluding remarks and a summary is offered in the final section.

2.0 Encouraging Vehicle Use Reduction Without Sticks or Carrots: A Brief Retrospect

Human beings have been described as moral animals (Wright, 1994). A distinguishing feature of human beings and civilisation is that they have highly developed thought processes that can be conceived as a 'moral compass'. The role of a 'moral compass' in the conduct of human life and civic duty has long been considered a significant phenomenon to address and harness through public policy (Smith, 1759). Throughout history, in several policy spheres (including charity support, religious observance, military service, public health campaigns, road safety, and environmental conservation and protection), appeals to a higher-order moral purpose and sense of obligation has often been a key element of government campaigns and social movements. The fundamental essence of constructing, shaping, and harnessing moral imperatives to serve public policy can accentuate the distinction in individual consciences, between activities that are self-serving and those that are deemed to be in the interest of the public good.

The moral tensions that drive a wedge between individual and collective interest have been the subject of considerable research scrutiny in a land-use planning context. This work has explored individual responses to the siting of LULUs (Locally Unwanted Land Uses) such as municipal waste incinerator plants (Schively, 2007) and public housing projects. Such sitings have generated NIMBY (Not In My Back Yard) preferences. LULUs often generate hostility despite their essential societal need and the requirement that they should be located 'somewhere'. Black *et al.* (2001) have termed the transport equivalent of these NIMBY preferences the OPCO effect; that is, a degree of acceptance by drivers for some policies that restrict vehicle use so long as it is (mainly) 'Other People's Cars Only'. The existence of an OPCO mentality by many drivers has prompted explicit policy interventions to serve the broad public interest.

Intervention by legally enforced regulations, as well as fiscal and market-based instruments, is meant to realign individuals' interests closer to public interest positions by the use of penalties, such as pricing, and incentives. These policy measures also operate in ways that minimise the scope to sustain 'free rider' problems. Intervention in public policy purely by appealing to a sense of moral obligation or civic duty is a 'soft measure' that entirely delegates the behavioural response of acceptance or dissent from the public message to individual conscience. Cairns *et al.* (2008) identified 10 soft policy measures in transportation

that entail use of persuasive public messages and marketing to support new social institutions and network building to boost uptake. However, some of these soft measures operate in conjunction with various penalties and incentives. In some cases, it is easier to target and induce collective uptake this way such as in relation to policies that are specific to particular organisations (for example, mandating school travel plans or workforce carpooling, and offering workforce bicycle grants and public transport tariff discounts).

Regardless of the co-elements of the transport policy mix deployed, soft measures contribute substantially to the volume of overall public and community messages. Further contributions also arise, from the civic duty and moral awareness aspects of campaigns and marketing initiatives designed to ease the public acceptability of hard policy measures, such as congestion charging (that is, pricing) (Halden, 2008). A significant cultural shift has taken place in the UK, and in other European countries, in approaches to transport policy and traffic management. This is evident in an emphasis on the road user as a customer who should be serviced by improved travel time reliability and by being kept informed of roadway conditions (this is, the consumer focus mentioned at the end of this paragraph). This shift is potentially significant when analysing road users' attitudes and designing communications strategies. For example, when assessing drivers' tolerance for congestion management measures, the assessment of moral viewpoints, attitudes, or acceptability can be viewed from the perspective of the consumer in isolation or from the perspective of a citizen of the community affected by change (Halden, 2008).

In essence, moral disposition and attitudes might differ according to the perspective from which the driver is viewing the issue. Conflicts between the desire to be good citizens and aspirations as consumers may prompt the same individual to behave in different ways when presented with options as a citizen, and when presented with the same options as a consumer. Reviewing the success of a number of soft-policy interventions based on social marketing, James *et al*. (2017) reveal mixed results and highlight that policies aimed at changing behaviour require some further consideration. Often it is the segmentation method of targeting such policies that provides a flaw to their efficacy (those with a moral obligation (interested in participating) are separated from those who feel no moral obligation to change (not interested in participating)). Further segmentation follows depending on the understanding of and motivation to use alternative modes to the motor vehicle. Further, post-travel surveys include the three segments and are weighted to represent the whole population. Anable (2005), for example, provides some insight to developing a way of categorising target groups in a more meaningful way. In this light, this paper estimates the impact of vehicle use decisions and household characteristics on the extent to which they feel a sense of moral obligation to reduce vehicle use.

3.0 Data

The data used in this paper is sourced from responses to a postal questionnaire survey of 2,495 households in six case study areas in Scotland during 2006. To the authors' knowledge, this is the only survey of its kind that includes a question on the moral obligation to reduce car use. The survey asked a random adult in the household to complete a four-day activity diary and a questionnaire about themselves, their household, and their partner/spouse if also living at the address. The survey was conducted as part of the

Engineering and Physical Sciences Research Council (EPSRC) Sustainable Urban Environments Programme, City Form: The Sustainable Urban Form Consortium (grant no. GR/S20529/01).

The six case study areas and the corresponding numbers of replies are as follows: Glasgow Central 49, Glasgow Darnley 25, Glasgow Pollokshields 71, Edinburgh Central 46, Edinburgh Corstorphine 50 Edinburgh Restalrig 39. The case study areas were selected as part of a wider research project undertaken by the CityForm consortium (City Form, 2009); see Jenks and Jones (2009) for details of the overall programme of research. The areas were selected to be of a similar population size but represent a range of different urban forms. Glasgow and Edinburgh have a number of different urban and suburban typologies from different time periods reflecting the range of urban typologies that are present in the UK. Urban and suburban typologies in Glasgow, Edinburgh, and other UK cities are reviewed in Frey *et al.* (2006). The case study areas selected for this study included an inner urban area, suburban area, and intermediate area from both Glasgow and Edinburgh, as shown in Figures 1 and 2. Each area includes at least 2,000 households, a mixture of land uses, various housing types, and nearby public transport (Jenks and Jones 2009).

There were 281 household responses to this survey. The authors are mindful of possible issues that arise from a low response rate in mobility surveys. Brög and Erl (1999), and Brög *et al.* (2009), identify potential shortcomings that may arise because of a low survey response rate. In particular, it is argued that the number of trips taken per day is likely to be overestimated in the face of lower response rates. With such caveats in mind, we note that the survey response rate is within the range achieved in similar studies making

Figure 1
Outer, Inner, and Intermediate Edinburgh Study Areas (from Left to Right)

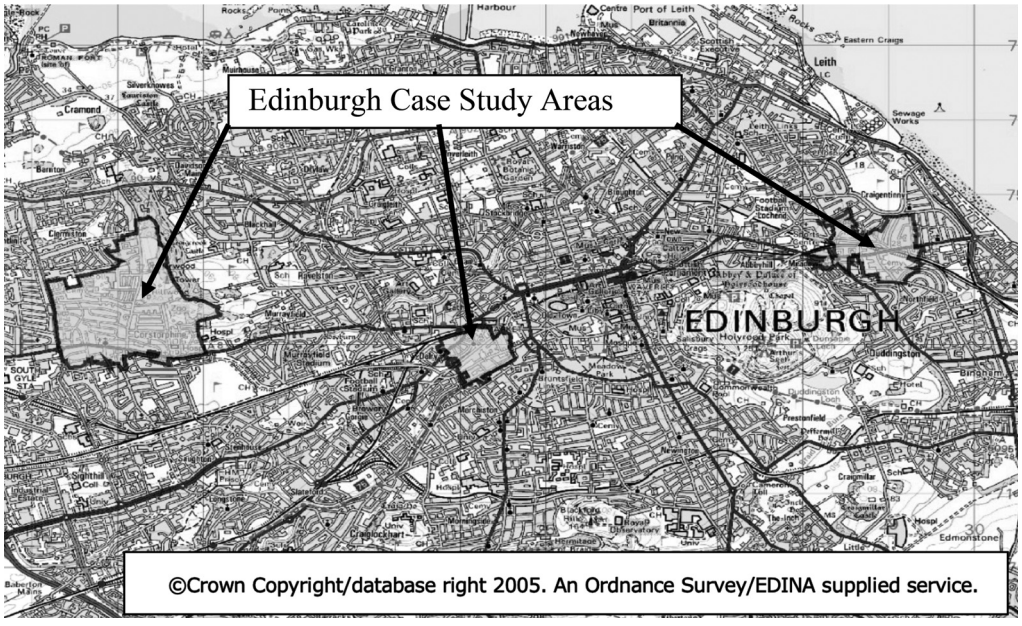
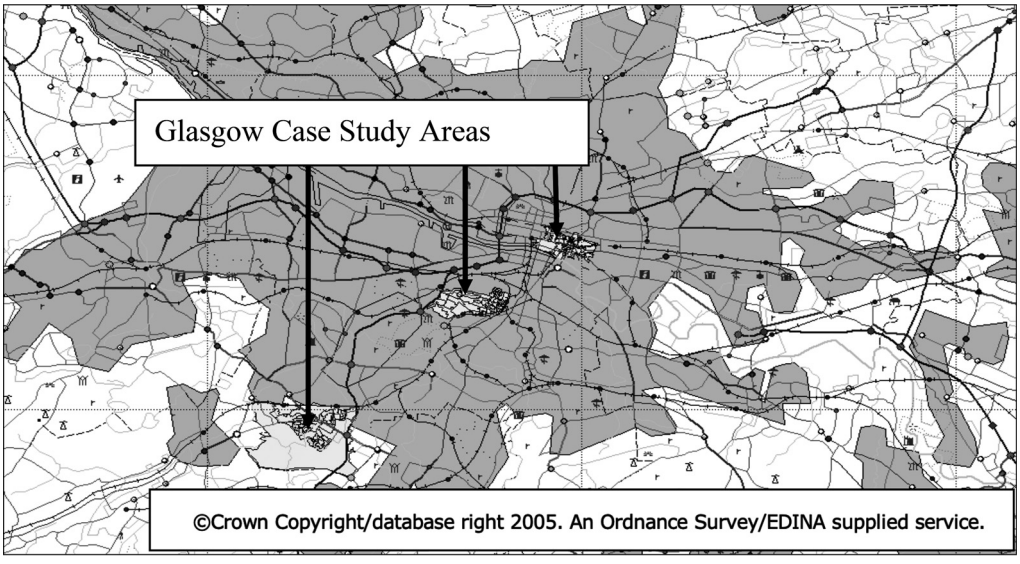


Figure 2
Outer, Intermediate, and Inner Glasgow Study Areas (from Left to Right)



use of travel diaries (note that measuring travel behaviour change is much more challenging than measuring changes in attitudes — such as willingness to change in the second paragraph below). Kitamura *et al*. (1997) followed a simple screening questionnaire with a three-day trip diary and a subsequent personal survey, achieving an overall response rate of 11 per cent. Xing *et al*. (2010) studied attitudes towards cycling in six small US cities, with a 12.6 per cent response rate. Axhausen *et al*. (2002) made use of a six-week travel diary as part of an attitudinal survey, achieving a response rate of 10.8 per cent. The 281 responses are less but still within the same order of magnitude as the 900 households used in Cervero and Day (2008), and greater than the 80 respondents used for a longitudinal travel study by Kenyon (2009). Stopher and Greaves (2007) provide a good overview of travel surveys and response rates.

The sample is approximately representative of a wider population of Scotland when compared to existing larger surveys. The Scottish Household Survey (SHS) 2007 reports that 70 per cent of 13,414 households have access to a car; this paper's sample shows 74 per cent. The SHS reports the percentage of households that have access or otherwise to vehicles. This paper's sample follows in parentheses: 30 per cent (26 per cent) of households have no car; 45 per cent (52 per cent) have one car; and 25 per cent (22 per cent) have two or more cars. The Scottish Transport Statistics 2010 data shows the average age of all vehicles to be 6.1 years old in 2006, similar to the sample used of 6.02 years old. However, we make use of design and post-stratification weights to render the database more representative of the wider population of Scotland.

While more recent survey data exists that measures willingness to reduce car use (NatCen Social Research 2017, Variable CCACar), this addresses quite a different question to the one examined in this paper, which is the sense of moral obligation to reduce their car use. In the British Social Attitudes data set, 35 per cent of respondents either agreed or

disagreed with the statement that they were willing to reduce car use. This proportion has stayed relatively constant over the most recent five waves of the survey. However, willingness to reduce car use does not indicate the reason for such a willingness, and a willingness does not indicate a behaviour. In this study, moral pressure to reduce car use is explicit in terms of the motivation and does quantify the behaviour (car ownership and use). The stable proportion of the population reporting a willingness to reduce car use over time suggests that the proportions reporting a moral obligation in this study may have also changed little in the intervening period since the data was collected. Similarly, while more recent data on car ownership and use exists (Department for Transport, 2016) these data sets do not have accompanying measures of moral obligation to change behaviours. As such, the data used in this study remains one of very few data sets that include both.

There are a small number of missing (unreported) observations in each variable we choose to include in the model. With the number of variables we use in estimation, using a case-wise deletion method reduced the observations available in our data set. To overcome this, we impute the small number of missing observations on a mean, median, or mode method — depending on variable type. We construct sample design and post-stratification weights to render the database more representative of the wider population of Scotland as follows:

- Design weight: This survey generates a sample profile based on property sales over a preceding three-year period (late 2002 to early 2006) in the six case study areas. The 2,495 addresses were targeted such that one-third were addresses where no sale had taken place and two-thirds were addresses where a sale had taken place. The design weight adjusts for the over sampling compared to the national level of property sales using data from Scottish Government Statistics.
- Post-stratification weight: We construct this weight using the following variables from the Scottish Census 2011: gender, age, household size, household tenure, car or van availability, accommodation type, economic activity, travel to work method.

Descriptive statistics are presented in Table 1, and the key elements are considered in turn.

3.1 Moral pressure

The dependent variable is the sense of moral pressure that an individual feels to reduce their use of private vehicles. The survey contained the statement 'I feel morally obliged to reduce my car use'. Respondents chose how much they agreed or disagreed from a five-point scale, ranging from 'strongly disagree' to 'strongly agree'. The distribution of responses to the statement is shown in Table 2.

This question was answered by households that did and did not own a vehicle. A sense of moral pressure may still be felt by individuals that do not own a vehicle or even report not to drive a private vehicle. While it is possible for us to summarise the data on the sense of obligation among non-car users (captives), perhaps their opinions are more abstract, since they are in essence hypothetical, and may or may not be based on previous experience as a car-user (non-captives — having a wider choice of travel modes that includes motor vehicles). As such, their preferences may be formed on different information sets or experiences. However, since the consequences or negative externalities attached to car use are most likely to be the determinants of the sense of moral obligation, and these externalities

Table 1
Descriptive Statistics of Key Variables

Variable	*Mean*	*Std. dev.*	*Min*	*Max*
'I feel morally obliged to reduce my car use' Ordered 1–5, 5 = Strongly agree	3.231	1.038	1	5
'I feel morally obliged to reduce my car use' 1 = Strongly agree or agree, else = 0	0.413	0.493	0	1
Total annual miles driven	10,124.30	15,872.47	0	150,000
Emissions (g per km)	125.109	81.652	0	284
No vehicles owned	0.281	0.450	0	1
One vehicle owned	0.516	0.501	0	1
Two vehicles owned	0.181	0.386	0	1
Three vehicles owned	0.021	0.145	0	1
Income up to £10,399	0.103	0.305	0	1
Income £10,400 to £15,599	0.082	0.275	0	1
Income £15,600 to £25,999	0.089	0.285	0	1
Income £26,000 to £31,199	0.078	0.269	0	1
Income £31,200 to £51,999	0.370	0.484	0	1
Income £52,000 or more	0.203	0.403	0	1
Distance to city (m)	3,132.90	2,257.73	0	8,742
Could not make more use of public transport	0.516	0.501	0	1
Expect to move in the next few years	0.399	0.490	0	1
Take children to and from school daily	0.125	0.331	0	1
Take children to leisure activities once a week or more	0.171	0.377	0	1
Safe cycle routes that extend beyond neighbourhood are important	0.420	0.494	0	1
Longstanding illness, disability or infirmity that limits activities	0.107	0.309	0	1

are common to all, we would not consider this a major concern. Thus, the analysis that follows is undertaken with and without these households.

3.2 Vehicle miles driven

Of key interest is the relationship between vehicle use and moral pressure to reduce vehicle use. Those that drive more may feel more pressure to reduce their car usage. The measure is self-reported *vehicle miles driven* per year, similar to that used in analysis of household surveys such as Frondel *et al*. (2011). Where more than one vehicle is owned, the household's total miles driven was used. It is important to note that there is no intertemporal element to the data set; as such, this variable is designed to capture the relationship between

Table 2
Distribution of Responses to 'I Feel Morally Obliged to Reduce My Car Use'

Response	*All households*	*Drivers only*
Disagree strongly	6.05%	7.43%
Tend to disagree	16.37%	21.29%
Neither agree nor disagree	36.30%	26.24%
Tend to agree	30.96%	32.67%
Strongly agree	10.32%	12.38%
Number of observations	281	202

vehicle use and moral pressure to reduce vehicle use in a single time period, and not a later adjustment of car use due to a feeling of moral obligation.

3.3 Household income and vehicle ownership

Money and morality are often linked, and could also be conceived in trade-off terms for some household income band categories, in the sense that some moral choices are costly and may be conceived in economic terms as 'luxury goods' with a high-income elasticity of demand. Accordingly, it is unlikely that moral pressure will influence many aspects of lower income households' lives, including car use deemed by them as essential. Yet even for higher income households, the interplay of morality and money embraces other general constructs of economic intuition — for example, that more is preferred to less and notions of conspicuous consumption goods that are used consciously or subconsciously to imbue societal status. Thus, those who cannot afford exuberant and possibly excessive vehicle ownership and use patterns may be inclined to adopt them 'rationally'. To control for such income effects, household income is recorded within income bands. The specified income bands are as follows: £0 to £15,599; £15,600 to £31,199; £31,200 to £51,999; and £52,000 or more. Households in the survey own between zero and three vehicles.

3.4 Vehicle attributes

Although there is likely to be a connection between energy efficiency and moral pressure, there are two potentially conflicting effects. First, households might have an energy-efficient vehicle because they feel a high level of moral obligation to reduce the externalities of their vehicle use. Second, their purchase of an energy-efficient vehicle may mitigate a sense of moral pressure. There is no clear way to identify these two categories. However, the empirical model will allude to which of these types is more dominant. The energy efficiency of a vehicle is measured by grammes of carbon dioxide per kilometre reported in the UK Government Vehicle Certification Agency (VCA) database, using reported model of vehicle, age, and engine details collected in the survey. Where more than one vehicle is owned, we use the average across these vehicles.

3.5 Proximity to urban centre

Urban sprawl effects are documented widely. In the context of Edinburgh, they have spurred public transport initiatives such as the widely publicised Edinburgh tram. To capture approximately the environment and local land in which people live, the distance of each household from the main city centre was included. Distance to the city centre is measured in metres from the geographical centre of each household postcode. This reflects that the availability of transport substitutes will generally be reduced further from the city centre, negating the propensity to feel moral pressure to reduce car use.

3.6 Household characteristics

In addition to the proximity to an urban centre, a sense of moral pressure to reduce vehicle use will likely vary depending on the mode choice options available. Responses to the statement 'I could not use public transport any more than I do at the moment' are used to approximate the extent to which a household is able to switch to public transport. (Note that this is predicated on people's understanding of transport options; in economics the assumption is that the market is fully informed.)

We already control for household income; however, the question 'Do you expect to move from this address in the next few years?' is used to help explore the ability to have greater choice of where they can choose to live and thus the household's access to different forms of land use.

The frequency with which children are taken to and from school and to leisure activities is used to capture interdependencies within households. Responses to the statement 'Safe cycle routes which extend beyond neighbourhood are important' are used to approximate the household's attitude to road and personal safety. Finally, responses to the question 'Do you have any longstanding illness, disability or infirmity that limits your activities in any way?' are used to capture households that may have difficulties switching between travel modes due to physical health.

4.0 Modelling Approach

This section outlines the empirical framework used to model the feeling of moral pressure in a household. The explanatory variables are of key importance to policy makers in revealing what types of drivers should be targeted by advertising campaigns or other policy initiatives. Given the discrete nature of the survey question, two alternative approaches are taken. In one approach, a general binary view of moral pressure is used as the dependent variable. In the other approach, the five categorical responses are treated as ordered.

4.1 Standard logit specification

Initially this study models the probability of answering 'agree' or 'strongly agree' to the statement 'I feel morally obliged to reduce my car use', using a standard binary choice logit framework. The limited dependent variable, *Moral*, is assumed to be a value of one for these two responses; zero is assumed for all other responses. This variable is assumed to be influenced by a range of vehicle, household and local regional attributes such that:

$$\begin{aligned}\text{Prob}\,(\text{MORAL}_i) = f(&\text{MILES DRIVEN}_i, \text{VEHICLE EMISSONS}_i,\\ &\text{NUMBER OF VEHICLES}_i, \text{INCOME}_i, \text{URBAN FORM}_i,\\ &\text{HOUSEHOLD CHARACTERISTICS}_i),\end{aligned} \tag{1}$$

where i is the observation denoting each household in the cross-sectional data set. Results from such a model will estimate the probability that an explanatory variable has some influence on feeling a sense of moral obligation. This model is estimated using a standard logit regression, which, as discussed elsewhere, is implemented with and without using sampling weights for comparison.

4.2 Ordered logit specification

Extending the standard logit, given the nature of the responses to the moral pressure question the responses are treated directly as being ordered such that 1 = 'strongly disagree' through to 5 = 'strongly agree'. Beyond this, the general model specification remains broadly the same as that given in equation (1). As with the standard logit, this model is estimated both with and without sampling weights applied; moreover, for both the standard

and ordered logit, estimation is conducted for the full sample containing all households, and again for just those households with vehicles.

5.0 Results and Discussion

Both the simple and ordered logit estimations produce quantitatively similar results. Further, the ordered logit estimation reports significant intercept coefficients at the lower end of the ordered choice categories of *Intercept 1|2* (between 'disagree' and 'strongly disagree'), and also at higher categories such as *Intercept 3|4* (between 'neither agree nor disagree' and 'agree'). Given these features of the estimation results, the discussion in this section focuses mainly on the results obtained from the ordered logit specification estimated for the full sample — model (3) in Table 3.

The estimated coefficients (defined in terms of log-odds ratios), standard errors, and respective t-probabilities are reported in Table 3. The estimates for *miles driven*, *emissions*, and *vehicle ownership* are statistically significant. The income bracket of *£52,000 or more* household income is also statistically significant. Additional contextual variables including *'Expect to move in the next few years'*, *'Take children to and from school daily'*, *'Take children to leisure activities once a week or more'*, *'Safe cycle routes which extend beyond neighbourhood are important'*, and *'Longstanding illness, disability or infirmity that limits activities'* are also significant. These results are considered in turn.

5.1 Vehicle miles driven

Holding other things constant, for those driving more miles, the probability of feeling a moral obligation to reduce car use is lower. Given that *miles driven* is a continuous measure, it is illustrative to consider the marginal effects at varying levels of miles driven. Figure 3 plots the marginal effects of distance driven for each of the five response categories, and demonstrates that households who drive further are much more likely to take a neutral position as to whether they feel a sense of moral pressure to reduce their car use. In the sample data, the average annual mileage is roughly 12,000 miles per household (excluding non-driving households).[1] At average levels of travel, households are most likely to be neutral or tend to agree. Agreement of feeling moral pressure reduces with the increase in car usage, giving way to a stronger sense of neutrality and disagreement. This gives rise to a possible avenue for policy design. There is an opportunity to make the average driver (in terms of distance) more aware of the externalities of their vehicle use and hence make them feel a greater sense of moral pressure to reduce their car use. In line with psychological paradigms of attitudes-perception-behaviour, the guiding principle should be to engender drivers with a perception of moral pressure. This would likely lead to behaviour changes in the future, as drivers move through the stages needed for behaviour change (Prochaska *et al.*, 2015), notwithstanding the mutual influence between behaviour and attitudes (Kroesen *et al.*, 2017).

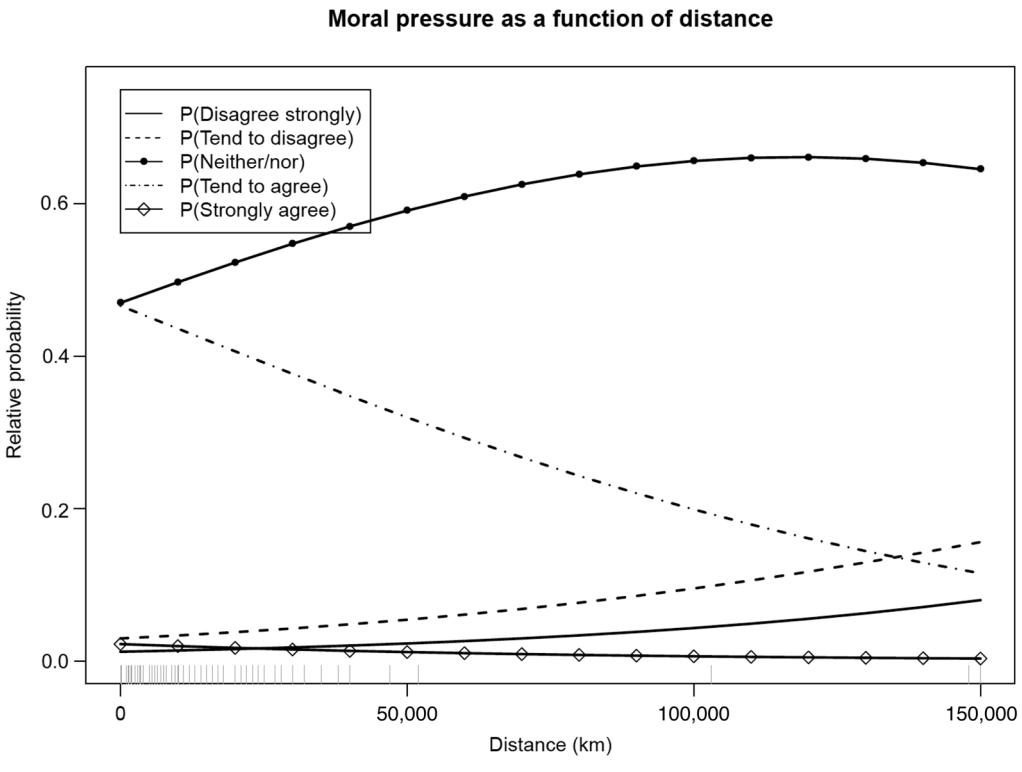
[1]This is approximately in accord with national averages shown in the National Travel Survey 2006 (Department for Transport, 2007).

Table 3
Estimates of Coefficients Using Logit and Ordered Logit

VARIABLES	*(1)* *Logit*	*(2)* *Logit drivers only*	*(3)* *Ordered logit*	*(4)* *Ordered logit drivers only*
Annual miles driven	−0.00003***	−0.00004***	−0.00001**	−0.00001**
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Emissions (g per km)	−0.018**	−0.009	−0.019***	−0.007
	(0.008)	(0.009)	(0.007)	(0.007)
No vehicles owned	−4.449***		−3.303**	
	(1.525)		(1.307)	
Two vehicles owned	−0.799*	−1.064*	−2.291***	−1.853***
	(0.481)	(0.591)	(0.428)	(0.428)
Three vehicles owned	5.408***	3.488*	7.944***	6.388***
	(1.941)	(1.932)	(1.254)	(1.345)
Income £10,400 to £15,599	−0.544	0.976	−0.756*	0.265
	(0.514)	(0.749)	(0.413)	(0.531)
Income £15,600 to £25,999	0.142	1.361*	−0.600	−0.105
	(0.520)	(0.804)	(0.464)	(0.570)
Income £26,000 to £31,199	−2.648	−0.850	−1.425	−0.663
	(1.686)	(1.525)	(0.983)	(0.916)
Income £31,200 to £51,999	0.262	1.718**	0.245	0.803*
	(0.416)	(0.720)	(0.313)	(0.482)
Income £52,000 or more	2.157***	2.895***	2.938***	2.387***
	(0.569)	(0.809)	(0.484)	(0.550)
Distance to city (m)	−0.0002***	−0.0003**	−0.0001	−0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Could not make more use of public transport	−0.105	−1.121**	0.176	−0.164
	(0.301)	(0.438)	(0.236)	(0.334)
Expect to move in the next few years	−1.684***	−2.339***	−1.470***	−1.485***
	(0.416)	(0.594)	(0.312)	(0.386)
Take children to and from school daily	4.488***	1.657	3.007***	2.048**
	(0.724)	(1.029)	(0.544)	(0.978)
Take children to leisure activities once a week or more	−2.391***	−1.169	−2.178***	−2.106**
	(0.899)	(0.832)	(0.659)	(0.836)
Safe cycle routes which extend beyond neighbourhood are important	0.449	1.062**	0.449*	1.034***
	(0.324)	(0.453)	(0.260)	(0.355)
Longstanding illness, disability or infirmity that limits activities	−1.264***	−2.544***	−1.180***	−1.084*
	(0.447)	(0.897)	(0.328)	(0.595)
Intercept 1|2			−7.487***	−4.451***
			(1.374)	(1.346)
Intercept 2|3			−6.218***	−3.064**
			(1.361)	(1.338)
Intercept 3|4			−3.034**	−1.099
			(1.325)	(1.316)
Intercept 4|5			0.705	2.226*
			(1.347)	(1.339)
Constant	4.188	2.331		
	(3.042)	(3.016)		
Observations	281	202	281	202
Log-likelihood	−157.8572	−88.37934	−382.8858	−266.1144

Notes: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 3
Marginal Effects for Distance



Note: Grey lines on the x-axis represent the location of individual observations.

As this survey data has no intertemporal element, the effects shown are variation between households rather than changes in behaviour of the same household over time. Thus, it is not possible to define the reasons for high vehicle use explicitly and the decline in agreeing that there is a moral pressure to reduce that use. Given the nature of the sample data, it is generally unlikely that this is due to low public transport accessibility. Several other socio-economic factors may influence this, such as household structure, and in particular the presence of children in a household; we are able to consider some of these factors explicitly below.

5.2 Household income and vehicle ownership

Households with a higher income are more likely to feel a sense of moral pressure to reduce vehicle usage. The estimated coefficient for highest income band of '£52,000 or more' is statistically significant for vehicle owners. This result offers some support to the notion that those in highly paid occupations have greater flexibility and resources to care for others. Owning none, two or more vehicles appears to have different implications to feeling moral pressure, compared to owning one vehicle. Households which do not own a vehicle feel less of a sense of moral obligation to reduce car use, which is a somewhat mechanical

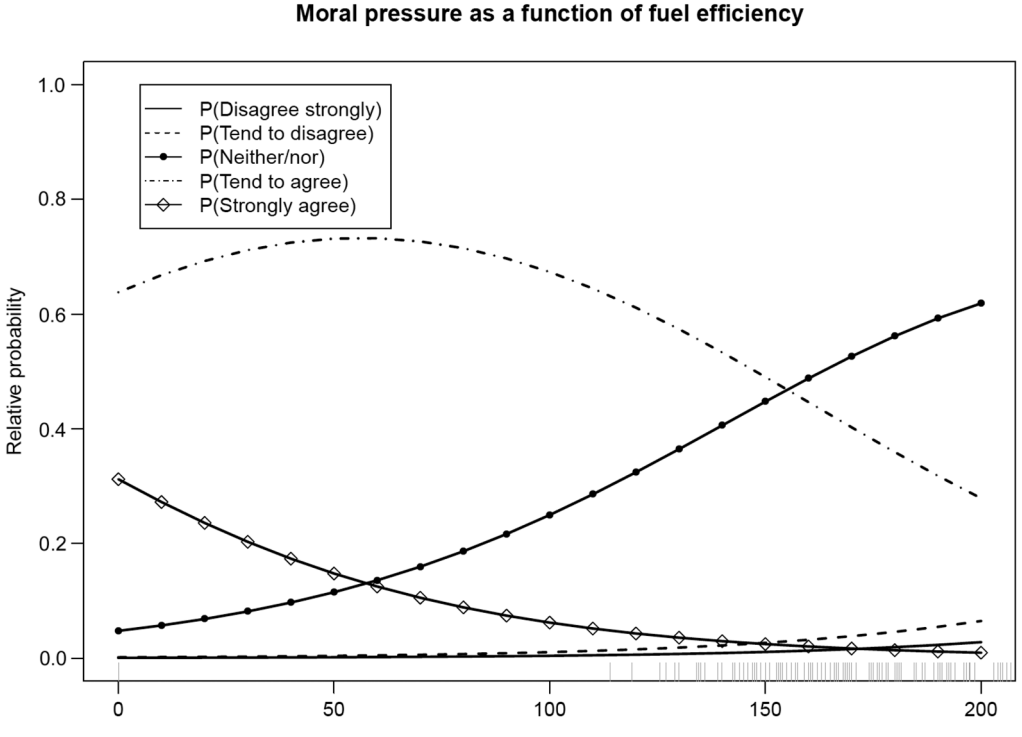
association but does provide some informal validation that the model is providing sensible results. Households with two cars generally feel less obliged to reduce their car use, while households with three or more cars have a heightened level of moral obligation. Speculating as to why, households with two cars may be expanding their vehicle fleet to accommodate more complex household travel requirements, while those with three or more may face a sense of guilty pleasure. Carefully characterising the potential causal links leading to this phenomenon is beyond the analysis presented in this model, but identifies an area for further research. Future research could specifically focus on household decisions and what affects behaviour change in the context of a household's present realities.

5.3 Vehicle attributes

Results imply that those households using more fuel-efficient vehicles are less likely to feel a moral obligation to reduce their use. Figure 4 shows the marginal effects of fuel efficiency for each of the five response categories, and demonstrates that households who own more fuel-efficient vehicles (emissions going to zero in our case) are more likely to 'agree' or 'strongly agree' that they feel a sense of moral pressure to reduce their car use. Agreement fades and neutrality rises with an increase in vehicle emissions, showing that households with the potential to provide greater environment damage are more likely to feel no sense of moral obligation to reduce the externalities of their vehicle use.

Figure 4

Marginal Effects for Vehicle Fuel Efficiency (Measured as Grammes of CO_2 Emissions per km)



Note: Grey lines on the x-axis represent the location of individual observations.

5.4 Additional contextual variables

Several contextual variables that relate to the demand or need for personal travel services are included in the estimated models, and are discussed here in turn. The first of these concerns whether a household needs to *'Take children to and from school daily'*. Results show a positive and significant coefficient; therefore, one might draw some implications about the potential influences of family structure to the likelihood of feeling a strong sense of moral obligation. Depending on the age group, schools are often local enough to be within walking distance for households; as such, a sense of moral obligation might arise from the availability of alternative modes of transport.

If households *'Take children to leisure activities once a week or more'*, then these households will have a lower likelihood of feeling morally obligated to reduce their car use. The implication here is that for these households, the car provides a necessary mode of personal travel that perhaps cannot be easily substituted for with another mode.

When asked if *'Safe cycle routes which extend beyond neighbourhood are important'*, for households that responded yes, they are likely to have a higher level of moral obligation to reduce their use of the car. This is consistent with the view that at least some of these cyclists might be willing to commute, displacing current car use, should the local cycling facilities/routes be enhanced.

Lastly, for individuals with *'Longstanding illness, disability or infirmity that limits activities'*, there is a lower propensity to feel morally obliged to reduce car use. This is intuitive given the possibility of vehicle modifications to accommodate infirmity or limited mobility. Households that *'Expect to move in the next few years'* are also less inclined to feel moral obligation, which may be rationalised against the heightened value of access to personal transport not only during the tumultuous period of moving home, but also while learning about the ease of access to services and facilities in the new dwelling area.

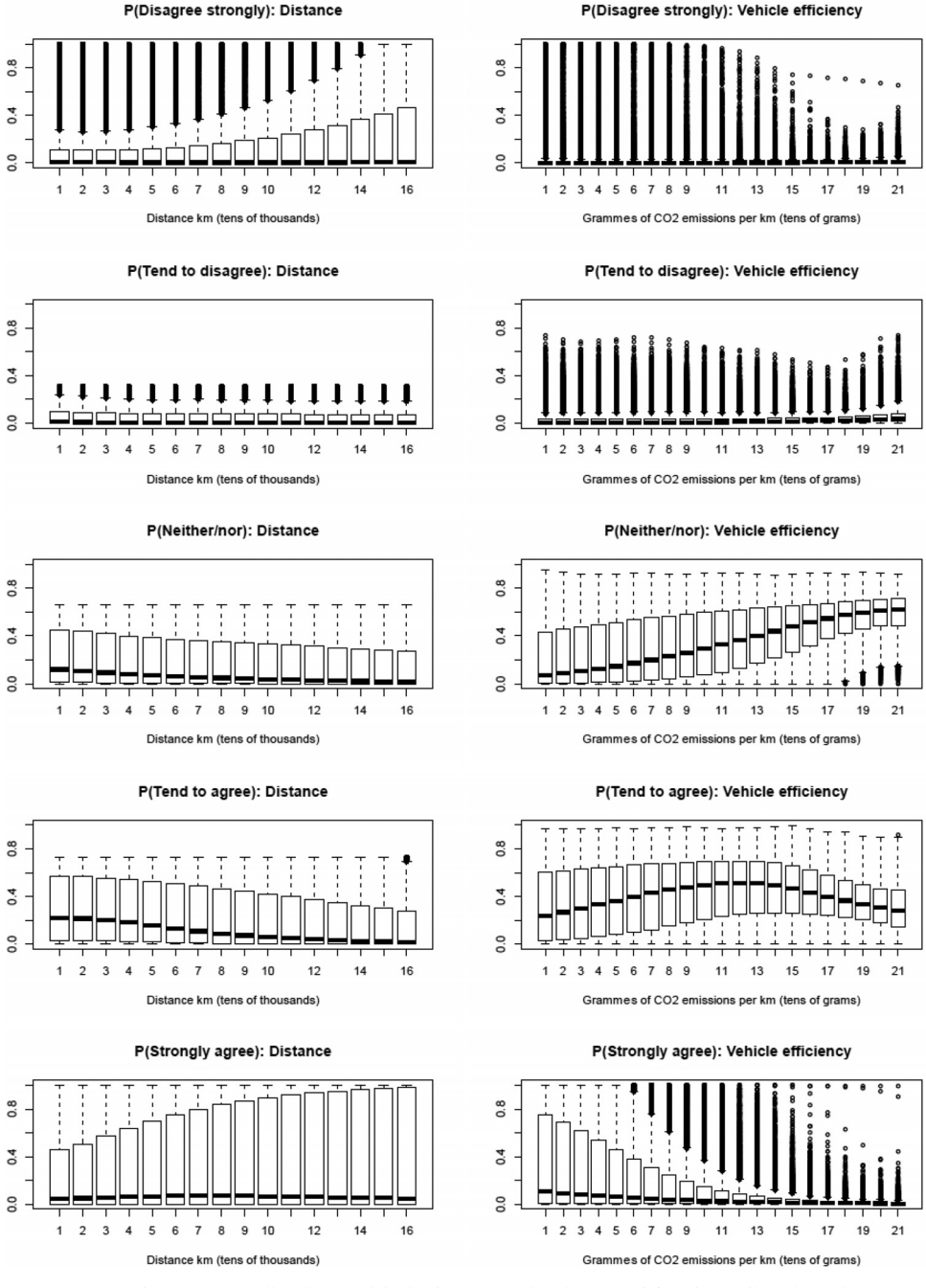
5.5 A note on sensitivity of the marginal effects

To establish the sensitivity/robustness of our main findings, in Figure 5 we provide boxplots for selected marginal effects, obtained using a bootstrap estimation procedure. Specifically, we take $B = 10{,}000$ new samples from the original data sample containing both driver and non-drivers, then re-estimate the ordered logistic regression, recording results only for those samples which: (i) converge properly; and (ii) contain all model coefficients. In cases where these two conditions are not satisfied we take a new draw, to ensure we are left with a total of B valid replications. The boxplots provide a snapshot of the variability/robustness of marginal effects estimated using the available data and the ordered logit specification.

The results here suggest a modest degree of sensitivity in the estimated model outcomes (comparing against the marginal effects shown in Figures 3 and 4), which is perhaps a reflection of the small sample sizes available for estimation. Notwithstanding this, there are also some core similarities in the slope and broad magnitude of the median effects shown in the boxplots with Figures 3 and 4. Those effects that are weak remain weak, while those that show more consistent variation across the sample data range do visibly vary. We take these plots somewhat cautiously as adding confidence around the sensitivity of our main results, but at the same time as a reminder that the sample size in our study is creating some potential model instability that might warrant further consideration in a future and expanded study of the issue of moral obligation.

Figure 5

Boxplots of Bootstrap Distributions (Complete) for the Estimated Marginal Effects



Note: $B = 10{,}000$ bootstrap replications, with the bootstrap implemented for the ordinal logistic regression model for the sample containing both drivers and non-drivers.

5.6 Some closing remarks on the relation between moral pressure, car ownership, car use, vehicle efficiency, and proximity to town

In this paper, we have largely neglected the possible associations that may exist between the decision to feel morally obliged to reduce car use, and attributes such as the level of car ownership in a household, the level of car use, proximity to the nearest town (general need for personal transport), and vehicle efficiency. It is plausible to conceive richer behavioural explanations than our modelling exercises above consider. For example, it is possible that moral pressure may vary with higher levels of vehicle use, or may have a causal influence over the decision to own a car.

These are not trivial concerns and, to address such types of questions, there has been growing interest in the use of latent-class hybrid choice models (HCM). We do not here review these models in any depth but, in brief, they permit the possibility to model joint choice outcomes and explore possibilities that the choice process is systematically influenced by latent attributes, which in the case of our paper here might take the form of moral pressure and its potential influence over car ownership or use.

We explored the potential for application of such models in our own study, and upon a general review of the literature felt that our sample size was likely to be too small to permit reliable or accurate estimation. Table 4 summarises the number of observations used in several existing studies using HCMs, which were identified through a general search from the Scopus database, excluding: (i) studies that have yet to be cited; (ii) studies that were not accessible from our institutions; and (iii) studies that are from proceedings and non-mainstream journals. As such, we recognise that this will not be exhaustive, yet we believe it offers a representative snapshot. The lowest number of observations in any of the papers was 200, although that was from a Monte-Carlo simulation exercise and not a specific empirical application. The smallest number of observations for an empirical application was 374, which is around 30 per cent larger than our own data set, while the average of the identified studies was 2,782, with a number of studies taking many more observations than this. Based on the identified studies, we are reticent to implement hybrid choice in the case of our own study primarily on the grounds of sample size considerations. Moreover, the extent of missingness and limitations over the range of variables to model and explain richer behavioural dynamics also bring into question the value of attempting a formal implementation of HCMs in our case. We do, however, concede the potential value of future studies on moral pressure and obligation with alternative and richer data, in considering formal HCM applications.

Notwithstanding the above discussions, we may nonetheless offer some reflection on the patterns of association between moral pressure, and attributes relating to vehicle ownership and use. Table 5 offers some additional summaries of the data that prove insightful. Regarding moral pressure and car ownership, there are several features that stand out. We do observe a general pattern that respondents 'strongly disagree' more as the level of car ownership is higher, increasing from 2.53 per cent for respondents with no vehicles up to 16.67 per cent for households with three or more vehicles. A similar increasing pattern is seen on the other end of the moral obligation spectrum ('strongly agree'). As such, we cannot dismiss the existence of an association between moral obligation and car use, but note also that: (i) similar monotonic patterns are not found for other obligation categories; and (ii) we lack sufficient information to be able to assert any proper causality.

Table 4
Summary of Observation Numbers for Papers Using Hybrid Choice Models

Year	*Document title*	*Authors*	*Journal title*	*Citations*	*Observations*
2015	A hybrid-choice latent-class model for the analysis of the effects of weather on cycling demand	Motoaki, Y., Daziano, R. A.	*Transportation Research Part A: Policy and Practice*	29	599
2016	A study on passengers' airport choice behaviour using hybrid choice model: a case study of Seoul metropolitan area, South Korea	Jung, S.-Y., Yoo, K.-E.	*Journal of Air Transport Management*	3	374
2015	Assessing goodness of fit of hybrid choice models an open research question	Motoaki, Y., Daziano, R. A.	*Transportation Research Record*	4	200
2012	Choice modelling and SEM: integrating two popular modelling approaches in empirical marketing research	Hildebrandt, L., Temme, D., Paulssen, M.	*Quantitative Marketing and Marketing Management: Marketing Models and Methods in Theory and Practice*	4	500
2012	Effects of incorporating latent and attitudinal information in mode choice models	Habib, K. M. N., Zaman, M. H.	*Transportation Planning and Technology*	8	10,000
2014	Effects of land use patterns on tour type choice: application of a hybrid choice model	De Abreu, E., Silva, J., Sottile, E., Cherchi, E.	*Transportation Research Record*	4	959
2014	Expanding scope of hybrid choice models allowing for mixture of social influences and latent attitudes: application to intended purchase of electric cars	Kim, J., Rasouli, S., Timmermans, H.	*Transportation Research Part A: Policy and Practice*	45	726
2014	Exploring the role of individual attitudes and perceptions in predicting the demand for cycling: a hybrid choice modelling approach	Maldonado-Hinarejos, R., Sivakumar, A., Polak, J. W.	*Transportation*	22	3,394

2014	Forecasting the demand for electric vehicles: accounting for attitudes and perceptions	Glerum, A., Stankovikj, L., Themans, M., Bierlaire, M.	*Transportation Science*	47	4,704
2015	Heterogeneous preferences towards landscape externalities of wind turbines: combining choices and attitudes in a hybrid model	Mariel, P., Meyerhoff, J., Hess, S.	*Renewable and Sustainable Energy Reviews*	28	1,435
2014	How are comfort and safety perceived by inland waterway transport passengers?	Marquez, L., Cantillo, V., Arellana, J.	*Transport Policy*	10	1,161
2008	Hybrid choice modelling of new technologies for car choice in Canada	Bolduc, D., Boucher, N., Alvarez-Daziano, R.	*Transportation Research Record*	70	1,877
2013	Incorporating pro-environmental preferences towards green automobile technologies through a Bayesian hybrid choice model	Daziano, R. A., Bolduc, D.	*Transportmetrica A: Transport Science*	81	1,877
2016	Modelling choice when price is a cue for quality: a case study with Chinese wine consumers	Palma, D., Ortuzar, J. D. D., Rizzi, L. I., Guevara, C. A., Casaubon, G., Ma, H.	*Journal of Choice Modelling*	9	1,077
2015	The effect of attitudes on reference-dependent preferences: estimation and validation for the case of alternative-fuel vehicles	Mabit, S. L., Cherchi, E., Jensen, A. F., Jordal-Jorgensen, J.	*Transportation Research Part A: Policy and Practice*	8	14,694
2016	The potential of electromobility in Austria: evidence from hybrid choice models under the presence of unreported information	Bahamonde-Birke, F. J., Hanappi, T.	*Transportation Research Part A: Policy and Practice*	8	1,449
2014	Using semi-open questions to integrate perceptions in choice models	Glerum, A., Atasoy, B., Bierlaire, M.	*Journal of Choice Modelling*	9	2,265
Average					2,782
Std. dev.					3,866

Notes: The number of observations in any given paper may vary across different estimation; moreover, the units of measure for the papers listed in this table vary — hence the reported observations numbers are indicative. The information in this table is obtained from the Scopus database. (Note that the papers reported in this table are not cited in the reference list since: (i) they are not part of the main text; and (ii) their reference details can be traced from this table.)

Table 5
The Relations Between Moral Perceptions, Car Ownership, Car Use, Vehicle Efficiency, and Distance to the Nearest City

Response	*Disagree strongly*	*Tend to disagree*	*Neither agree nor disagree*	*Tend to agree*	*Strongly agree*
By car ownership level					
Drivers and non-drivers					
No vehicles	2.53%	3.80%	62.03%	26.58%	5.06%
One vehicle	6.21%	24.14%	26.90%	31.72%	11.03%
Two vehicles	9.80%	13.73%	27.45%	35.29%	13.73%
Three + vehicles	16.67%	16.67%	0%	33.33%	33.33%
All	6.05%	16.37%	36.30%	30.96%	10.32%
Distance to nearest city/town					
Drivers and non-drivers	2,906.471	3,333.283	2,878.471	3,415.448	2,995.069
Drivers only	2,858.867	3,497.349	3,628.057	3,251.818	3,282.600
Car use (mileage)					
Drivers and non-drivers	8,742.606	11,347.765	7,199.231	10,573.994	17,932.711
Drivers only	9,908.287	12,139.470	13,664.098	12,404.461	20,396.972
Vehicle efficiency					
Drivers and non-drivers	155.19608	164.09058	89.26961	131.88697	151.35632
Drivers only	175.8889	175.5388	171.8019	173.8510	175.5733

For the other three variables reported in Table 5 (distance to the city, mileage, and vehicle efficiency), we do not find any particularly strong monotonic associations. Instead, the values are seen to fluctuate up and down as we move from 'disagree strongly' to 'strongly agree' in the case of all variables, and when looking at the full sample or the restructured drivers-only sample. On this basis, while we are not strictly able to exclude a richer behavioural story, we can at least learn that if it does exist, it is non-trivial in nature.[2]

[2]In an additional modelling exercise, and in response to valuable comments from an anonymous referee, we considered a multinomial logit specification. While doing so does not mimic HCM, and also puts aside the issue of ordinality in choice outcomes, it can still offer a lens on a more complex type of heterogeneity in the determinants of choice outcomes and a richer underlying functional form. Unfortunately, we struggled to obtain satisfactory convergence — hence these results are not reported here. Similarly, in related additional testing we estimated a generalised ordinal logistic regression in which ordered-choice probability thresholds are made a function of observed variables (such as vehicle ownership) and therefore become heterogeneous, and which can be compared against a standard ordinal response model using a likelihood ratio test. The results, not reported here, indicate that such heterogeneity may indeed be present, yet we opt not to report these results within the main text, since we: (i) already elevate this as an issue for future research to address directly; and (ii) remain cautious over the statistical reliability of our testing owing to the modest samples sizes we have available for estimation. This also remains an important issue for future work to address in new surveys.

6.0 Summary and Concluding Remarks

The principal finding is that moral pressure varies systematically with attributes such as income, vehicle specific characteristics, and vehicle usage. Households in this Scottish survey that are less likely to feel a sense of moral pressure are those who make greater use of their personal vehicle, drive more polluting vehicles, are of a lower income, own two vehicles, and expect to move in the next few years. While the authors are mindful of the sample size, results are shown to be statistically significant.

These findings suggest a focus to shape future transport policy: to target policy instruments to those drivers/households with the attributes identified as significant, with the aim of raising awareness of the externalities of vehicle use. How this 'soft' transport policy guidance could actually be operationalised is not addressed in this study, but is an opportunity to circle back to inventive soft-sell strategies that could capitalise on this finding. However, such strategies would need to be accompanied by measures that lock in the benefits; otherwise, any potential capacity of the road network freed up by those with a sense of moral obligation to reduce their use could induce greater car use by those who feel no such moral pressure (Cairns *et al*., 2008).

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